INVESTIGATIONS OF THE DUST CONTENT OF THE ATMOSPHERE

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SYNOPSIS

This paper is a continuation of papers on the same subject that appeared in the MONTHLY WEATHER REVIEW for March, 1924, and June, 1925. It summarizes measurements of the dust content of the atmosphere made on the campus of the American University, District of Columbia, between December, 1922, and June, 1931, inclusive, excluding the month of June, 1923. This gives 9-year means for the winter and spring months and 8-year means for the summer and fall. The monthly averages and the annual totals show a gradual increase in the dust content of the atmosphere for the years 1923–1928, with a slight decrease in the years 1929 and 1930. Records of the total solar radiation received on a horizontal surface show that an increase in atmospheric dust has been accompanied by a decrease in the solar radiation intensity during the cold half of the year, November to April, inclusive, without a corresponding decrease during the warm months of the year. The greatest percentage of increase in the atmospheric dust content is shown in the minimum amount recorded in each month, where the annual average for 1930 was more than double that for 1923 and 1924.

This increase in local atmospheric dust does not appear to have been accompanied by a corresponding decrease in the distance to which prominent objects like mountain peaks and high hills can be seen.

A relation is shown between the sulphur (SO_2) content and the dust content of the atmosphere.

SUMMARY OF ATMOSPHERIC DUST MEASUREMENTS

The campus of the American University, District of Columbia, where atmospheric dust measurements have been made by the United States Weather Bureau since December, 1922, is in a sparsely settled suburb of Washington about 5½ miles northwest of the United States Capitol, 5 miles from all important railroads, and 2 miles northwest of the section known as Georgetown, of which that portion along the river front is largely given up to industry. The building of residences in this suburb is quite active, however, and the apartment-house section is much nearer, as well as more extensive, than it was in earlier years. Since apartment houses usually burn bituminous coal for heating, with inefficient stoking, it is not surprising that a summary of the atmospheric dust counts, given in Table 1, shows increased dustiness of the atmosphere, and especially during the cold half of the year, November to April. The years 1929, 1930, and 1931 have been an exception to this general rule, in so far as the monthly means and monthly maxima are concerned, but not in respect to the monthly minima. This is significant, as it indicates a permanent local pollution of the atmosphere that is gradually increasing in intensity. The recent decrease in the monthly means and monthly maxima may be attributable in part at least to the unusually warm winters of 1929-30 and 1930–31, and the resulting decrease in coal consumption.

TABLE 1.—*Dust content of the atmosphere at the American University, District of Columbia, at 8 a. m. (dust particles per cubic centimeter)*

MONTHLY MEANS

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual means
1922	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1, 228	-----
1923	1, 061	905	540	476	393	-----	397	388	386	395	451	557	540
1924	719	533	409	645	376	420	539	326	335	598	1, 110	1, 159	597
1925	723	1, 092	909	753	416	507	480	484	514	608	787	1, 444	726
1926	1, 631	1, 517	1, 370	755	573	578	542	532	565	692	851	1, 056	888
1927	1, 011	1, 116	939	721	729	607	933	760	859	1, 021	1, 097	1, 176	914
1928	1, 455	1, 450	1, 232	856	668	596	757	675	774	1, 082	979	1, 227	978
1929	1, 419	1, 086	652	610	621	469	549	626	638	616	858	881	752
1930	898	736	668	753	614	544	573	828	866	1, 020	995	875	781
1931	906	951	809	815	608	631	-----	-----	-----	-----	-----	-----	-----
Average	1, 091	1, 043	836	709	555	544	596	577	617	754	891	1, 047	772

TABLE 1.—*Dust content of the atmosphere at the American University, District of Columbia, at 8 a. m. (dust particles per cubic centimeter)*—Continued

MAXIMUM

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual means
1922	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2, 088	-----
1923	3, 680	2, 050	1, 155	1, 182	905	-----	793	794	812	853	1, 023	2, 340	1, 394
1924	2, 403	1, 964	1, 280	1, 661	1, 154	1, 250	1, 953	796	823	1, 366	1, 987	2, 551	1, 595
1925	1, 352	2, 370	2, 247	7, 077	781	991	1, 016	1, 037	1, 109	1, 432	1, 558	3, 106	2, 006
1926	3, 828	2, 995	2, 999	1, 527	1, 042	1, 035	985	941	1, 073	1, 426	3, 975	2, 388	2, 018
1927	3, 511	2, 474	1, 877	1, 558	1, 529	1, 560	1, 651	1, 443	1, 672	3, 133	2, 566	2, 984	2, 168
1928	3, 620	3, 557	2, 617	2, 039	1, 575	1, 434	1, 308	1, 302	1, 493	2, 772	2, 751	4, 116	2, 382
1929	3, 620	1, 982	1, 583	1, 153	1, 082	897	922	976	1, 010	1, 098	1, 628	1, 606	1, 463
1930	3, 780	1, 512	1, 176	1, 166	1, 701	855	1, 052	1, 323	1, 426	2, 066	1, 953	1, 779	1, 649
1931	1, 617	1, 649	1, 352	1, 434	846	1, 073	-----	-----	-----	-----	-----	-----	-----
Average	3, 046	2, 284	1, 810	2, 089	1, 179	1, 137	1, 210	1, 076	1, 177	1, 761	2, 180	2, 551	1, 792
Absolute maximum	3, 828	3, 557	2, 999	7, 077	1, 701	1, 560	1, 953	1, 443	1, 672	3, 133	3, 975	4, 116	-----

MINIMUM

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual means
1922	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	298	-----
1923	214	105	113	113	65	-----	90	110	59	96	71	90	108
1924	124	97	76	151	124	155	124	87	97	155	113	124	118
1925	57	77	87	202	149	197	132	143	118	130	124	344	147
1926	160	298	223	227	187	214	218	145	132	82	76	145	176
1927	155	185	145	138	225	122	288	187	218	99	172	143	173
1928	160	254	162	174	126	202	384	132	126	334	120	109	190
1929	160	200	101	242	134	128	170	191	176	124	323	204	179
1930	361	253	237	241	134	178	150	144	278	384	231	376	247
1931	372	369	174	233	275	216	-----	-----	-----	-----	-----	-----	-----
Average	196	204	146	191	158	176	194	142	150	176	154	204	174
Absolute minimum	57	77	76	113	65	122	90	87	59	82	71	90	-----

The dust counts have been made by Mr. Hand on all working days except on the few occasions when he was absent from the city and an observer was not available to take his place. An Owens jet dust counter has been used in collecting the dust and a microscope magnifying 1,000 diameters to determine the number of particles per unit of space. For a description of the Owens instrument see the earlier paper in the REVIEW for March, 1924.

THE RELATION BETWEEN ATMOSPHERIC DUSTINESS AND SOLAR RADIATION INTENSITY

From time to time short notes have appeared in the MONTHLY WEATHER REVIEW with reference to the diminution in solar radiation due to local smoke. (See the MONTHLY WEATHER REVIEW, October, 1924, vol. 52, p. 478, fig. 5; April, 1925, vol. 53, p. 147; January, 1926, vol. 54, p. 19; and January, 1929, vol. 57, p. 18.) Table 2 shows a general depletion at the American University, District of Columbia, in the annual totals of solar radiation for 1923–1928, and in the monthly averages during the cold part of the year for the period 1923–1930. The monthly averages for the warm part of the year show little departure from normal values. The depletion in solar radiation intensity is what would be expected from the increase in atmospheric dustiness shown in Table 1.

A similar decrease in solar radiation intensity recorded at Madison, Wis., is attributed by the official in charge of that station to increased smokiness of the atmosphere due to a marked increase in the population of the section of the city in which the Weather Bureau office is located. (See the MONTHLY WEATHER REVIEW, 1931, vol. 59, p. 272.)

TABLE 2.—*Departures of monthly totals of solar radiation received on a horizontal surface at Washington, D. C., from monthly normal values for the period 1914–1931 (gram-calories per cm.²)*

Year	January	February	March	April	May	June	July	August	September	October	November	December	Year
1923	−1,145	−859	−645	−419	+646	+311	+58	−1,179	−1,086	−73	−648	−248	−5,278
1924	+286	+289	+160	+675	−766	−1,867	+1,590	+740	−1,355	+1,549	−467	−640	−6
1925	−413	−721	+35	+98	+966	+979	+85	+1,176	−574	−2,373	−175	+28	−959
1926	−14	−1,176	+1,099	+784	+2,072	−1,071	−847	−2,919	−1,827	−959	−700	−917	−6,475
1927	−686	−1,001	−2,079	−1,064	−2,772	−105	+77	−1,260	+406	+452	−690	+307	−8,415
1928	+112	+77	+245	−1,050	+56	−972	+1,764	−1,032	−1,701	+672	+364	−245	−1,740
1929	−217	+1,162	−854	−1,288	+532	+1,274	+2,541	+2,002	+637	+511	−308	−219	+5,778
1930	−742	+119	+413	−161	+2,443	+777	−1,216	+3,045	+1,281	+2,681	−455	+222	+8,405
Means	−352	−273	−203	−303	+397	−84	+500	+72	−527	+308	−382	−214	−1,067
Departures	−8%	−4%	−2%	−3%	←———		+0.1%			———→	−6%	−5%	

ATMOSPHERIC DUST AND VISIBILITY

In the paper of June, 1925, already referred to, it was shown that the product

$$D \times N \times R.\ H.$$

approximates to a constant, C, where D = distance in miles to the most distant object that can be seen, N[1] = the number of dust particles per cubic centimeter, and $R.\ H.$ = the relative humidity expressed as a percentage.

A recomputation of the data there given for $D = 10$ miles or more, and applying weights corresponding to the number of observations, gives 444,000 for the value of C.

A summary of dust and visibility measurements made between May, 1925, and June, 1931, inclusive, and given in Table 3, gives for the weighted mean value of C corresponding to visibilities in excess of 25 miles, 432,000, or approximately the value found from earlier observations. For shorter distances of visibility C has increased in value by from 50 to 100 per cent.

This is interpreted to mean that the local dust cloud has so little extent that it does not materially interfere with the visibility of prominent objects at moderate distances, while the most distant objects still require the most favorable conditions to be distinguished.

TABLE 3.—*Relation between atmospheric dustiness and visibility of distant objects*

SUMMER					WINTER				
Number of observations	N=dust particles per cubic centimeter	$R.\ H.$, per cent	D=visibility, miles	$C=D \times N \times R.\ H.$	Number of observations	N=dust particles per cubic centimeter	$R.\ H.$, per cent	D=visibility, miles	$C=D \times N \times R.\ H.$
35	155	62	40.4	388,000	19	158	62	33.3	331,000
103	253	69	27.5	480,000	15	250	54	34.7	468,000
114	353	65	24.2	555,000	34	198	59	33.9	366,000
128	445	70	20.1	626,000	21	362	64	25.4	588,000
100	556	68	20.7	783,000	28	448	66	24.8	733,000
119	647	70	16.0	725,000	35	553	65	21.0	755,000
95	751	75	15.8	847,000	49	652	69	20.0	900,000
118	851	72	12.1	741,000	26	751	67	18.4	926,000
69	943	72	11.8	801,000	48	857	60	16.0	823,000
91	1,075	73	9.2	788,000	35	943	67	13.3	840,000
62	1,311	77	7.5	757,000	58	1,091	70	10.1	771,000
33	1,641	74	5.4	656,000	54	1,341	74	8.9	883,000
6	2,636	79	8.0	1,666,000	56	1,704	71	6.6	799,000
					38	2,446	75	3.8	703,000
					9	3,595	85	2.1	642,000

A copy of the dust counts made at the American University, District of Columbia, is mailed each month to Dr. J. S. Owens, London, England, superintendent of observations, investigations of atmospheric pollution, department of scientific and industrial research. In a letter received after this paper was completed Doctor Owens transmits the following results of his study of the observations for the year April, 1930–March, 1931. The equation that he developed seems to give with considerable accuracy the relation between N, $R.\ H$, and V ($V = D$ of this paper). He says:

Visibility and wind velocity are given in the returns sent in, and an attempt has been made by examining the whole of the figures for the year to find some relation between visibility, number of suspended particles, and relative humidity. The result obtained is indicated in the curve (fig. 1) given below:

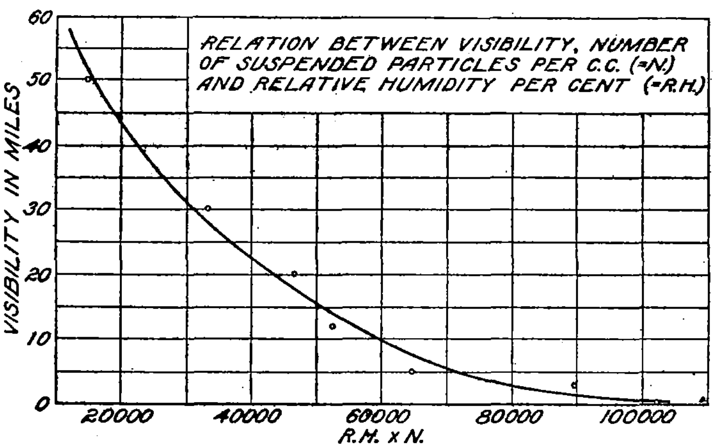

FIGURE 1.—Relation between visibility, V; number of suspended particles, N; and relative humidity, $R.\ H.$

This was the result of many trials of different combinations between number of particles and relative humidity. To get consistency in the results, it is evident that some provision should be made to eliminate the effect of varying wind direction. The dust counts were made at one particular point, whereas visibility was governed by the conditions as to dust, etc., at other places along the line of view. It is evident therefore that the wind direction might make a great difference in the apparent relation between visibility, so measured, and dust contents. To eliminate this, only the days with a north wind were taken and other days neglected. The visibility, relative humidity and number of dust particles were tabulated and averages obtained of the relative humidity and dust counts for the different visibility distances. The curve given (fig. 1) is for visibility plotted against the product of relative humidity and the number of dust particles.

The wind velocity is not taken into account in this curve because it appeared reasonable to assume that it was one of the factors governing the number of particles and was therefore already taken account of in the figure for the number of particles per cubic centimeter. The curve is remarkably smooth and agrees well with the equation

$$V = 340 - 69 \log (RH \times N)$$

where V = visibility in miles, RH = relative humidity, and N = number of particles per cubic centimeter.

[1] This N must not be confused with N = the number of nuclei of condensation found by the use of the Aitken dust counter.

This is not quite the same as the equation evolved by Doctor Kimball (see the REVIEW for June, 1925, 53:243), in which he gives the visibility in terms of the relative humidity and number of particles as—

$$V=\frac{390,000}{RH\times N}\quad\text{(approx.)}$$

It seems probable that any expression for visibility of this form would break down when approaching the point of saturation of the air, as in this neighborhood, apart from the effect of special pollution by hygroscopic salts, we might expect a rather sudden loss of visibility rather than a gradual one.

Since to obtain this curve (fig. 1) only days with a north wind were taken, it is not to be expected that the equation will apply when the wind is not north. Indeed, we can not hope for any general expression relating to dust count, relative humidity, and visibility until and unless we know the conditions along the line of vision. It would appear, however, that, knowing these conditions, there is good ground for believing that a simple relation might be established.

MEASUREMENTS OF THE SULPHUR (SO_2) CONTENT OF THE ATMOSPHERE

Method of measurement.—Equal quantities of a solution of distilled water, iodine, potassium iodide, and soluble starch were placed in two 20-liter bottles, each bottle being tightly sealed but provided with a ground-glass stopcock. The pressure within one bottle was reduced to one-half of the current atmospheric pressure, the stopcock closed, and the bottle was then shaken vigorously in order to have the liquid wash around the entire interior glass surface, and then the stopcock opened, the bottle being vigorously shaken until normal atmospheric pressure was resumed inside of it. The liquid in the comparison bottle was also similarly shaken, but the air was not disturbed within this bottle, a detail merely to approximate similar conditions in the two bottles.

The liquids in the two bottles were than placed in titration bottles; and if the tint of blue in each bottle was the same, no indication of the presence of sulphur evidenced itself. If, however, the tints differed, simple titration methods with the use of potassium iodide and other simple chemicals were resorted to in order to bring them to the same tint of blue.

TABLE 4.—*Dust particles per cubic centimeter and volumetric sulphur content of the atmosphere in parts per million*

Day of month	1926 November Dust	Sulphur	1926 December Dust	Sulphur	1927 January Dust	Sulphur	1927 February Dust	Sulphur	1927 March Dust	Sulphur	1927 April Dust	Sulphur
1	718	0	1,046	0.20			1,667	0.30	1,436	0.10	145	0.10
2	519	T.	145	0			519	T.	1,044	T.	260	0.15
3	1,529	0.20	1,756	0.85	1,730	0.40	1,000	0.10	166	0		
4	853	0.05	1,558	0.50	676	0.15	1,243	0.25	187	T.	781	T.
5	781	0.40			897	0.25	239	T.	1,027	0.20	607	0.45
6	1,044	0.90	676	0	729	0.10					1,193	0.20
7			918	0.35	859	0	1,462	0.15	1,147	0.30	155	0
8	250	0.35	1,126	0.20	781	0.25	[1] 1,831	0.20	414	0	498	0.10
9	225	0.40	1,453	0.10			1,777	0.40	1,625	0.40	149	T.
10	78	0	901	0.35	896	0.60	2,474	0.65	1,201	0.55		

[1] Additional data for Feb. 8:

Time	Dust, particles per cubic centimeter	Sulphur, parts per million
10 a. m.	2,470	0.95
11 a. m.	2,066	0.45
Noon	790	0.10
1 p. m.	607	T.
2 p. m.	680	0.25
3 p. m.	1,216	0.40

TABLE 4.—*Dust particles per cubic centimeter and volumetric sulphur content of the atmosphere in parts per million*—Continued

Day of month	1926 November Dust	Sulphur	1926 December Dust	Sulphur	1927 January Dust	Sulphur	1927 February Dust	Sulphur	1927 March Dust	Sulphur	1927 April Dust	Sulphur
11	365	0.10	498	0.20	584	0.35	1,426	T.	1,877	0.70	991	0
12	779	0.10			1,243	0.70	2,234	0.50	376	0.30	353	0.10
13	1,256	0.75	1,457	0.10	603	0.35					1,457	0.25
14			781	0.25	187	0.10	223	T.	145	0	571	T.
15	288	0.15	1,111	0.15	785	0	834	0.25	972	0.20	983	0.40
16	90	0	727	0			1,348	0.40	1,256	0.30	498	T.
17	844	0.10	1,653	0.35	985	0.20	197	T.	1,672	0.85		
18	781	0.60	521	0	3,072	1.60	376	0.10	498	T.	1,046	0.15
19	1,004	0.35			1,359	0.45	523	0.20	1,130	0	1,529	0.80
20	1,518	0.55	2,024	0.45	607	0.60					729	0.10
21			[2] 2,388	0.70	361	0.40	1,676	T.	823	0.35	225	0
22	781	0.40	344	1.25	155	0.15			622	0.40	106	0
23	916	0.65	834	0.75			1,151	0.20	1,310	0.15	386	T.
24	1,646	2.65	1,546		773	0.65	365	0.10	586	T.		
25					1,947	0.50	1,567	0.75	1,182	0.10	590	0
26	[3] 3,975	3.10			651	0.10	185	0	922	T.	970	0.10
27	143	T.	1,319	0.80	260	0					1,457	0.25
28			309	0	3,511	0.45	1,348	T.	676	0.15	130	0
29	521	0.40	628	0.20	1,044	0.15			918	0	1,319	0.10
30	370	0.10	386	0.45					1,252	0.20	1,558	0.15
31			1,359	0.65	586	T.			886	0.10		

Day of month	1927 May Dust	Sulphur	1927 June Dust	Sulphur	1927 July Dust	Sulphur	1927 August Dust	Sulphur	1927 September Dust	Sulphur	1927 October Dust	Sulphur
1			475	0	464	0	1,443	T.	1,424	0.05	796	0
2	229	0.05	897	0	918	0	300	0	813	T.		
3	674	0.15	678	0			1,044	T.			1,210	0.05
4	596	0.20	1,436	0			1,098	T.			99	0
5	622	0			1,006	0.20	918	0			680	T.
6	1,516	T.	149	0	624	0	622	0	374	0	1,252	0.10
7	899	0.10	674	0.15	1,204	T.			970	0	970	0.05
8			307	0	806	T.	1,239	0	1,651	0	307	T.
9	271	0.20	603	0	834	0	674	0	288	0.05		
10	727	0	865	T.			288	0	708	0	1,193	0.15
11	603	0	1,147	T.	731	0	708	0			1,525	0.20
12	806	0.10			1,128	0	1,004	0.05	374	0	918	0.10
13	246	0	143	0	922	T.	1,233	T.	1,042	0	225	0
14	353	0	603	0.05	353	0.10			1,518	0.05	813	T.
15			729	T.	1,457	0	225	0	983	T.	[4] 3,133	2.40
16	225	0	164	T.	288	T.	781	0	781	T.		
17	269	0	813	0.20			1,233	0	1,193	0.10	1,646	0.25
18	1,529	0	888	0	1,037	0	187	0			286	0
19	1,252	0			918	T.	225	0	407	0	162	0
20	422	0	[5] 271	0.15	785	0.10	1,004	T.	353	0	307	0
21	1,466	0.10	832	T.	1,006	0			416	0	363	0
22			256	0.20	1,338	0.15	1,214	0.05	218	0	790	0
23	1,138	0	584	0	601	0.10	229	0	496	0		
24	496	0	1,560	T.			435	0	1,214	T.	1,518	0.35
25	928	0.15	441	T.	1,006	T.	225	0			1,042	T.
26	458	0			1,046	0	804	T.	1,518	0.05	601	0.15
27	386	0	122	0	781	0	1,252	0	1,672	0.05	1,552	0.20
28	624	0	363	0	1,426	0.05			790	0.10	1,346	0.15
29			218	0	993	T.	498	0	813	0.05	1,840	0.25
30			554	T.	1,651	0.10	645	0	601	0		
31	1,483	0.15					991	0			1,976	0.15

Day of month	1927 November Dust	Sulphur	1927 December Dust	Sulphur	1928 January Dust	Sulphur	1928 February Dust	Sulphur	1928 March Dust	Sulphur	1928 April Dust	Sulphur
1	1,000	T.	496	0			1,784	0.20	1,443	0.10		
2			976	T.			729	0	680	0	1,155	0
3	435	0.10	269	0	1,672	0.20	2,070	0.25	943	0.10	966	0
4	601	0			825	T.	1,768	0.20			2,029	0
5	905	0	166	0	1,000	T.			441	0	695	0.40
6			393	T.	1,243	0.05	1,042	0.10	2,617	0.55	907	0
7	1,105	0.10	1,436	0.25	1,651	0.10	3,511	0.90	2,188	0.40	699	0
8	1,661	0.40	676	T.			970	0	1,672	0.20		
9	1,911	0.10	363	0.05	1,730	0.20	813	0	2,020	0.95	878	0
10	2,566	0.55	836	0.25	2,184	0.45	1,453	0.15	622	0.10	645	0
11	1,621	0.20			689	0.10	622	0			475	0.20
12	603	0	1,394	0.20	985	T.			2,190	0.80	252	0.30
13			2,043	0.35	2,961	0.50	2,358	0.35	1,831	0.65	177	0

[2] Dense smoke cloud enveloped university this date; 4,502 particles of dust per cubic centimeter at 1:30 p. m.
[3] Much soot.
[4] Haze in west; local smoke with noticeable sulphur odor.
[5] Spores.

TABLE 4.—*Dust particles per cubic centimeter and volumetric sulphur content of the atmosphere in parts per million*—Continued

Day of month	1927				1928							
	November		December		January		February		March		April	
	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur
14	1,182	0.10	145	0	1,558	0.10	2,066	0.20	2,886	1.30	178	0
15	884	T.	1,831	0.40			254	0	405	0		
16	2,512	0.45	2,598	1.10	2,297	0.55	1,665	1.10	2,402	0.35	418	0
17	1,420	0.20	143	0	1,042	0.20	1,348	0.25	1,764	0.20	1,533	0
18	359	0			1,667	0.40	727	0.80			456	0.25
19	172	0	496	T.	2,176	0			164	0	1,321	0
20			796	0.45	813	0	1,651	0.10	557	0	1,533	0.10
21	970	0	1,651	0	729	0	1,350	0.20	953	0.20	2,039	T.
22	783	0	521	0.35			983	0.30	689	T.		
23	1,203	0	1,453	0.20	943	0	1,825	0.10	556	0	1,113	0.45
24					2,251	0.20	689	0	882	0	867	0.40
25	811	0			160	0	1,432	0.20			174	0
26	1,940	0			1,539	0.10			1,853	0.10	672	0
27			2,253	0.15	899	0.10	832	0	376	0	894	0
28	874	0	2,795	0.60	183	0	804	0.25	1,764	0.20	252	0.20
29	916	0	1,037	0.20			3,557	1.20	1,809	0.10		
30	403	0.10	1,646	0.30	3,620	0.65			170	0	1,073	0
31			2,984	0.50	2,050	0.15			162	0		

Day of month	1928											
	May		June		July		August		September		October	
	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur	Dust	Sulphur
1	966	0	569	0			628	0			334	0.20
2	490	0	964	0.20	384	0	655	0			1,485	1.15
3	981	0			865	0	196	0			1,401	0.25
4	1,163	T.					403	0			655	0.40
5	1,575	0	376	0.10	1,107	0.25					672	0.20
6			275	0	420	0	563	0	437	0	796	0.45
7	811	0	914	0.10			846	0.15	731	0		
8	315	0	1,434	0.25			1,151	0.20	632	0.15	1,308	0.65
9	126	0.10	594	0			571	0.30			1,401	0.30
10	336	T.					790	0	1,493	0.25	687	T.
11	934	0	1,132	T.			359	0.45	286	0	1,258	1.60
12	134	0	286	0.15	1,308	0.20			571	0.20	830	0.40
13			605	0.25	1,014	0.10	132	0	1,092	0.30	1,199	0.55
14	821	0	202	0	386	0.30	527	0	302	0		
15	351	0	655	0			586	0	832	0.10	2,163	1.50
16	494	0.10	722	0	586	0	701	0.10			1,596	1.10
17	1,006	0.25			628	0	773	0	1,294	0.40	2,772	1.75
18	216	0.35	788	0	386	0	655	0	1,159	0.30	1,888	0.65
19	502	0.20	336	0.10	821	0			361	0	788	T.
20			907	0.20	947	0	1,117	0.25	126	0	351	0
21	620	T.	202	0.10	672	0.10	1,302	0.35				
22	603	0	410	0			437	0			998	0.20
23	1,210	0.25	426	0.15	727	0.10	672	0			1,258	0.45
24	294	0			865	0	899	0.10	861	0.25	739	T.
25	403	0.35	206	0	722	0	662	0	1,064	0.35	840	0.25
26	235	0.10	972	0.15	1,049	0			880	0.30	393	0.20
27			594	0	714	0	907	0.25	1,453	0.90	628	0.35
28	1,006	0.25	588	0	861	0	594	0.30	586	0.20		
29	868	0.10	458	0.05			351	0	538	0.55	697	0.60
30			284	0	470	0	626	0			872	0.55
31	437	0			[6] 972	1.20	1,109	0.40			1,210	0.75

[6] Haze.

Table 4 gives the daily sulphur measurements, together with the determination of the dust content of the atmosphere. The two measurements were made at the same place and the sulphur determinations followed immediately the dust measurements.

Table 5 summarizes the atmospheric sulphur determinations. From May to August, inclusive, on at least half the days on which determinations were made, not a trace of sulphur was found, and from April to September, inclusive, on more than half the days the amount present was not measurable (T. or 0). Also, from April to August, inclusive, the measured amount did not exceed in volume 0.45 parts per million, and in the majority of cases it did not exceed 0.2.

An amount in excess of one part per million in volume was measured on only 15 days out of the 600 on which measurements were made. Five of these days were in October, 1928, and were accompanied by an unusual number of dust particles, which quite probably came from a furnace that was being operated by the nitrate fixation laboratory on the American University campus to reduce certain rock material for the purpose of extracting phosphoric acid and potash. Eight of the remaining ten days with much sulphur were also days with many dust particles, the maximum of sulphur, 3.1 parts per million, on November 26, 1926, having as its accompaniment 3,975 dust particles per cubic centimeter. October 15, 1927, with 2.4 parts of sulphur per million had 3,133 dust particles per cubic centimeter, and there was a noticeable odor of sulphur from local smoke. December 22, 1926, with 1.25 parts of sulphur per million had only 344 dust particles per cubic centimeter, but it was raining at the time, and this would have a tendency to precipitate local dust from the lower atmospheric layers. On July 31, 1928, with 1.2 parts of sulphur per million, only 972 dust particles per cubic centimeter were collected by the Owens jet dust counter, but a note states that there was a dense haze, with the wind from the south. Such a wind would bring smoke from the industrial section of Georgetown.

The chemical process used in measuring atmospheric sulphur records in units of 1 part in 20,000,000 by volume, while it is generally conceded that 2 parts in a million is noticeable by its sulphur odor to the average individual.

TABLE 5.—*Summary of atmospheric sulphur determinations*

Parts per million	Average monthly occurrences											
	November	December	January	February	March	April	May	June	July	August	September	October
0	7.5	5.5	4.5	4.0	7.5	11.0	14.0	12.5	12.5	17.5	9.0	4.5
T	2.0	2.0	2.0	3.5	3.0	3.0	2.0	4.5	3.5	3.0	2.0	3.5
0.05 to 0.20	7.0	6.0	9.0	8.0	8.5	7.0	7.0	7.5	5.5	3.0	6.0	7.0
0.25 to 0.45	4.0	6.5	4.5	5.0	4.0	4.5	2.5	1.0	1.0	3.5	3.5	5.5
0.50 to 0.95	3.0	4.0	4.5	2.5	3.5	0	0	0	0	0	1.0	3.0
1.00 or more	1.0	1.0	0.5	1.0	0.5	0	0	0	0.5	0	0	3.0
Average number of days	24.5	25.0	25.0	24.0	27.0	25.5	25.5	25.5	23.0	27.0	21.5	26.5

These sulphur determinations were made at the request of the United States Bureau of Standards. They constitute a link in a series of tests made in cooperation with the International Nickel Co. in a study of the durability of wire screens under different conditions. Measurements made in Pittsburgh represented conditions in an industrial city. Measurements at the navy yard, Portsmouth, Va., represented seacoast conditions, where the atmosphere contains many salt crystals. The campus of the American University, District of Columbia, was expected to approximate open-country conditions.